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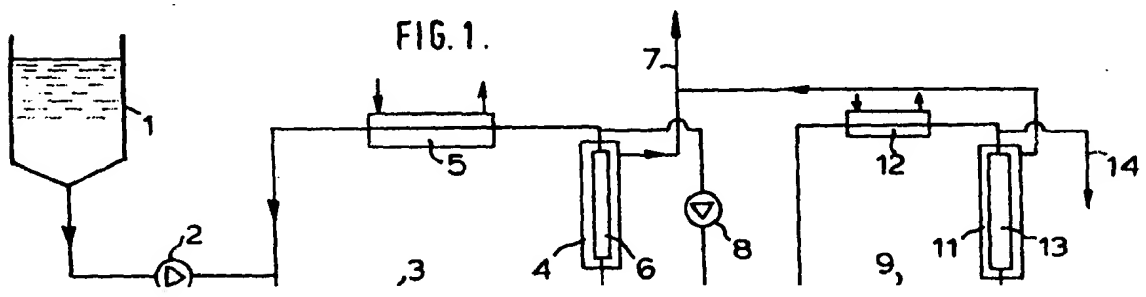
(54) Beer filtration

(57) Beer or beer residue (tank bottoms) is filtered by cross-flow filtration using porous ceramic membranes. In a two stage filtration process beer is drawn from tank 1 by a centrifugal pump 2 to a primary filtration stage comprising a circuit including a circulating centrifugal pump 3, a ceramic membrane filter 4 and a cooler 5. A proportion of the circulating liquid is drawn off by a positive pump 8, and passed to a similar secondary filtration stage. A proportion of the retentate is drawn off via a line 14. This retentate is of a pasty consistency and normally has a commercial value, in that it is free of Kieselguhr or other filter aid. The membrane filters 4, 11 comprise elongate porous ceramic blocks having parallel through channels, each channel lined by a ceramic membrane of finer pore size than the block.

FIG. 1.



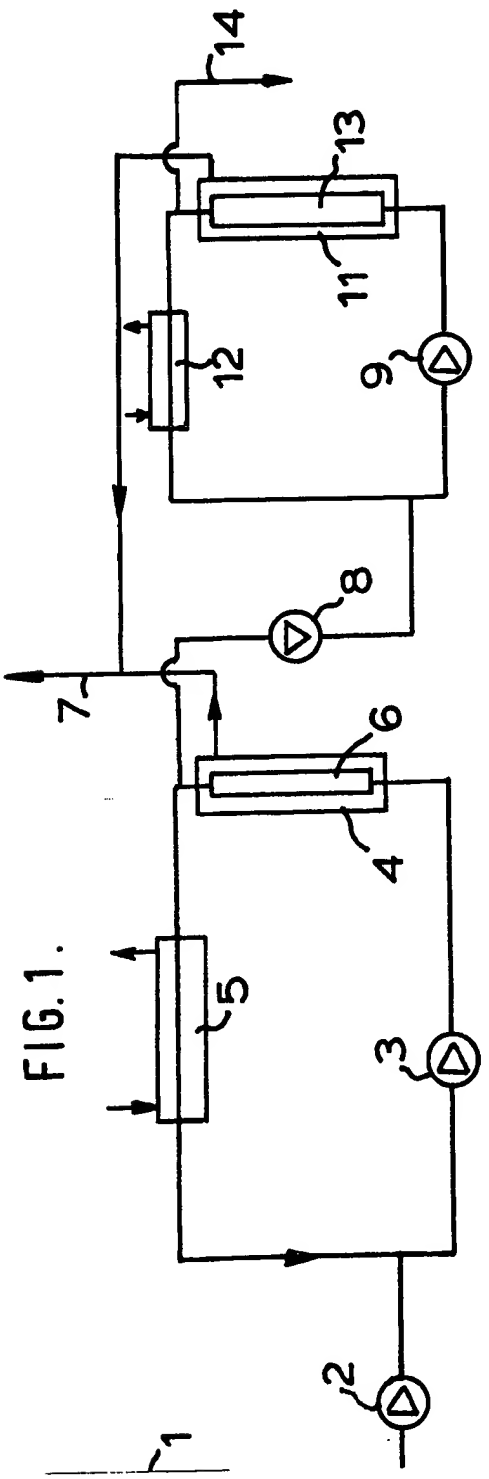
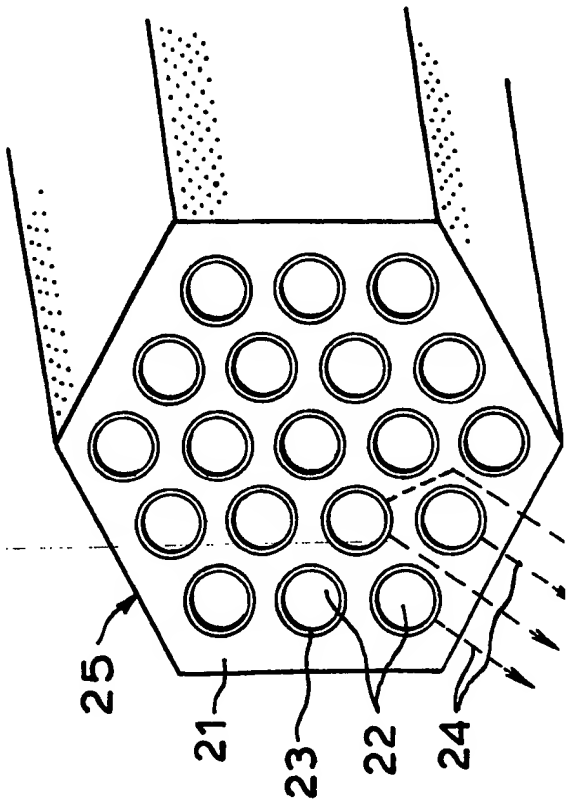


FIG.1.

FIG.2.



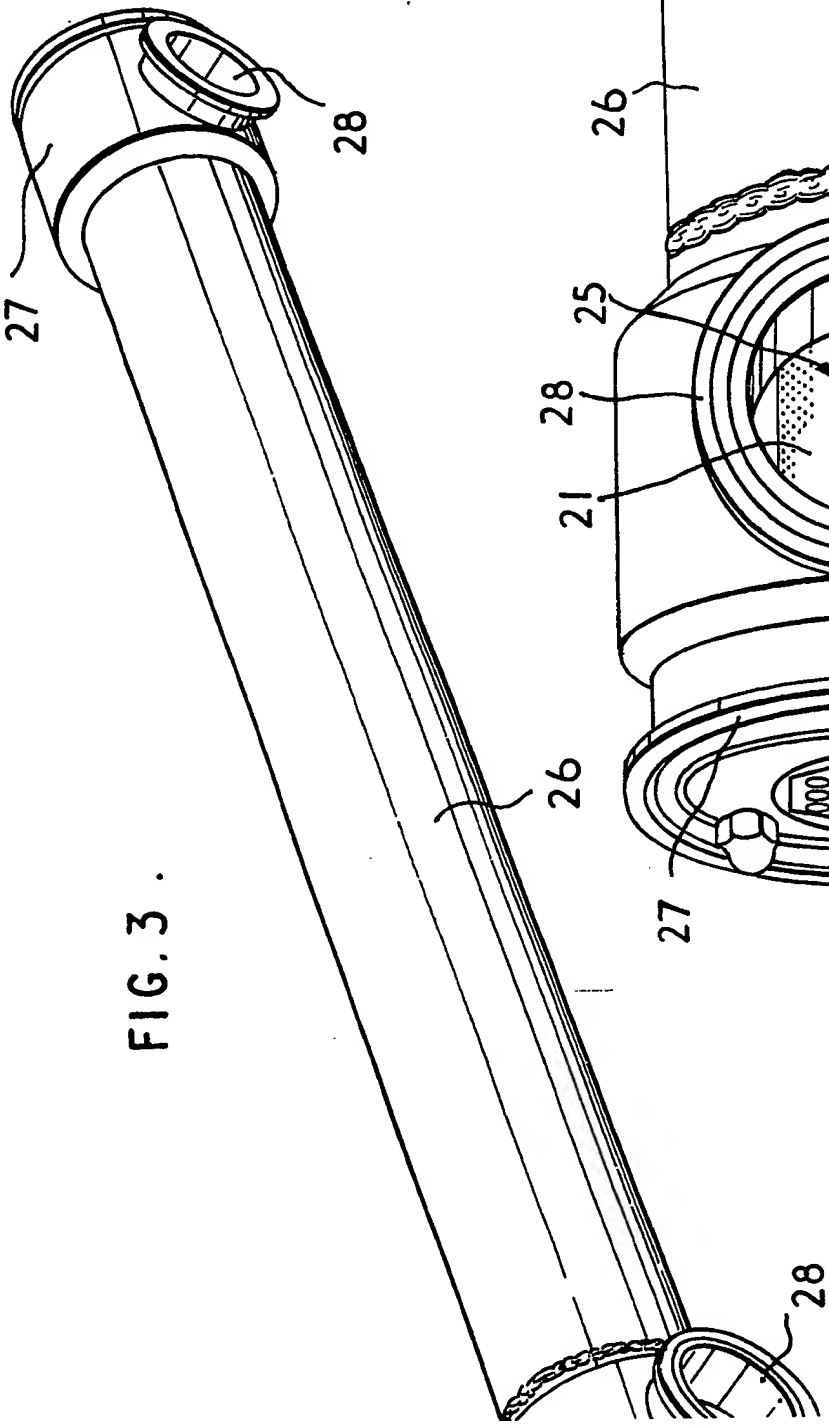


FIG. 3.

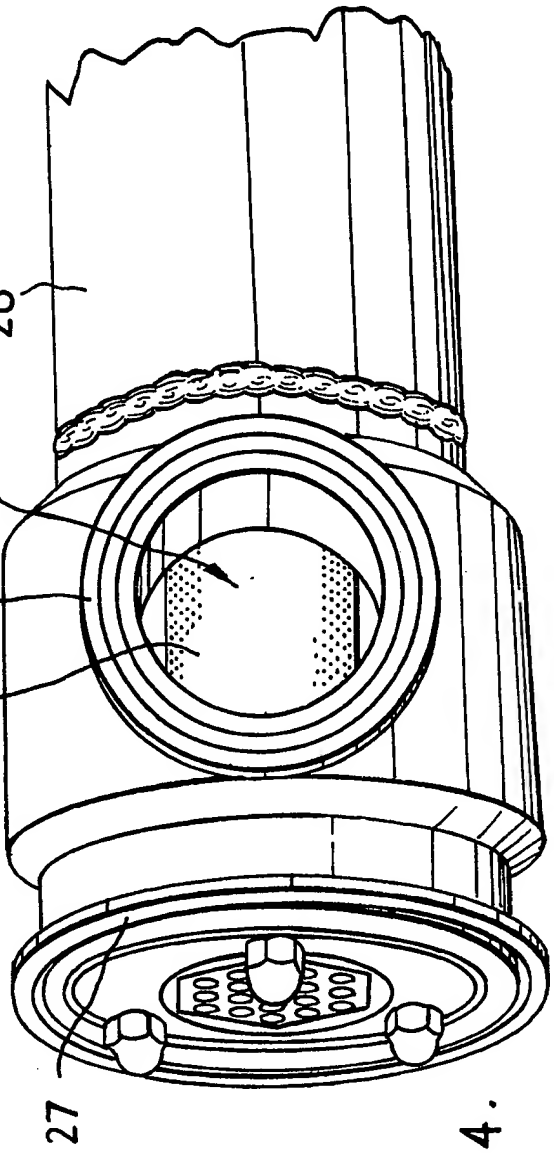


FIG. 4.

SPECIFICATION

Beer filtration

This invention relates to the filtration of beer.

Beer is normally filtered at a late stage in the production to clarify it and to remove particles such as yeast cells which may have been carried over from earlier production stages. Also, the liquid, known as tank bottoms, remaining in a vessel, such as a fermentation or maturation tank, after the usable beer has been pumped off, is essentially beer with a large, typically 6%, content of suspended solids. The solids content depends on the type of beer and the practice in the brewery concerned. The beer may be recovered in usable form after a filtration process. However, in view of the high solids content, the filtration process normally entails positive pumping, which may increase the dissolved oxygen content and decrease the dissolved CO_2 content, which may adversely affect the quality and shelf life of the beer, even if it is mixed back into the bulk of the beer emerging from the normal filtration.

In what follows, the term "beer" is intended to include tank bottoms and similar beer-based liquids with high suspended solids content, unless the context appears to require otherwise.

For these filtration processes for beer, it is conventional to use a filtration process involving a filter aid, such as Kieselguhr. This material is used in large quantities in the brewing industry, but since it is potentially carcinogenic, difficult to handle and also expensive, its elimination would be widely welcomed in the industry.

Under current UK practice, excise duty is paid on beer fermented, so beer lost with tank bottoms, on which duty has been paid, may represent a significant commercial loss.

As an alternative to the conventional filtration process, proposals have been made to use a process of cross-flow membrane filtration. In cross-flow filtration, the beer is caused to flow across a membrane, so that a filter cake is not built up, but the solids content of the retentate is increased by passage of the permeate through the membrane. Such a process would be automatic in operation and would therefore require no labour. Also, the use of a filter aid is avoided, and effluent problems consequent upon its use are also eliminated. A high yield should be obtained. The avoidance of build-up of a filter cake means that the flux rate is maintained for long periods. A disadvantage is that the retentate must remain sufficiently liquid to be pumpable, and so some beer is lost with the retentate drawn off from the system.

However, these processes have been based on the use of polymeric membranes mounted, as is

It has now been found that ceramic membranes may be used satisfactorily for the filtration of beer by a cross-flow filtration method.

In accordance with a first aspect of the present invention, there is provided a method of filtering beer (ss hereinbefore defined) by a cross-flow filtration process, in which the filtering medium is formed by one or more ceramic membranes.

In accordance with a second aspect of the present invention, there is provided apparatus for filtering beer (as hereinbefore defined) by a cross-flow filtration process, in which the filtering medium is formed by one or more ceramic membranes.

In accordance with a third aspect of the invention, there is provided plant for the manufacture of beer, including apparatus for filtering beer (as hereinbefore defined) by a cross-flow filtration process, in which the filtering medium is formed by one or more ceramic membranes.

The invention further comprehends beer when filtered by a method or in an apparatus in accordance with the invention as set forth above.

A ceramic membrane essentially comprises a layer of porous ceramic material with a pore diameter of the required size. For micro-filtration, this would be in a range from 0.1 to 10 microns, while smaller pore sizes would be appropriate for ultra-filtration or reverse osmosis. In the case of beer filtration, the pore size would normally be in the range for micro-filtration, probably between 0.2 and 5 microns, and would be chosen in dependence on the brewing process used.

The membrane is supported on a body of coarse pore ceramic material, e.g. alumina with a pore size of 15 microns, and the body and membrane may be sintered together. In a preferred form of ceramic membrane, the support body may be an elongate module, and may have a plurality of parallel longitudinal channels each lined with a thin membrane layer of the fine-pore ceramic material. An end area of the module would have the body coated to seal it and would protrude into a header zone for parallel feed to the channels. The retentate would emerge into a similar header at the discharge end, also sealed by a coating on the body, while permeate would pass thorugh the body and into an outer casing from which it would be recovered. The outer casing would normally contain a plurality of such modules, so as to build up a commercially useful filtration area.

A ceramic membrane is robust, and technically it may constitute a micro-filter, so it gives a high throughput rate with effective filtration of beer. In addition to the advantages which are claimed for cross-flow filtration using polymeric membranes, the ceramic membrane may be cleaned by back-

whole content of a tank, or the product of a continuous process, may be fed to a primary filtration stage in which it is circulated past ceramic micro-filtration membranes. The permeate would constitute the bulk of the usable beer, while the retentate would have a high suspended solids content, for example 4%, which is comparable with tank bottoms. A proportion of the retentate would be passed on to a secondary filtration stage, also using ceramic micro-filtration membranes and a more positive mode of pumping appropriate to higher solids contents, to recover more beer and raise the solids content of the retentate to 16 or even 20%.

In either stage, the circuit for circulation past the membrane arrangement could include a cooler.

The invention will be further described with r ference to the accompanying diagrammatic drawings, in which:

Figure 1 is a flow diagram showing one preferred mode of filtering beer to produce a clear product prior to packaging;

Figure 2 is an perspective sectional view showing part of a typical ceramic membrane module;

Figure 3 is a perspective view of a filter unit incorporating one such module; and

Figure 4 is an enlarged view of one end of the unit of figure 3, from a different angle.

In the process and apparatus shown in figure 1, beer is drawn from a tank 1, which may be a settling or maturation tank from a batch process, or it may be a buffer tank in a continuous brewing process, by a centrifugal pump 2 to a primary filtration stage comprising a circuit including a circulating centrifugal pump 3, a filter 4 and a cooler 5. The filter includes one or more cross-flow filter units based on ceramic membrane modules 6, the permeate thorugh which is clarified beer nwhich is drawn off on a line 7. The retentate is recirculated through the cooler 5.

A proportion of the circulating liquid, with its enhanced solids content, comparable with tank bottoms, is drawn off by a positive pump 8, and passed to a secondary filtration stage, again comprising a circuit including a circulating positive pump 9, a filter 11 and a cooler 12. The filter 11 again includes one or more cross-flow filter units based on ceramic membrane modules 13, the permeate through which is clarified beer which is drawn off and passed on to the line 7. The retentate is recirculated through the cooler 12.

A proportion of the retentate is drawn off via a line 14. This retentate is of a pasty consistency and normally has a commercial value, in that it is free of the primary filtration stage, and a further 3% from the secondary filtration stage.

Turning now to figures 2, 3 and 4, these show typical forms of ceramic membrane and modules incorporating them.

Figure 2 shows a commercially available form of ceramic membrane module 25, comprising a body 21 of porous alumina in the form of a rod of hexagonal section and having a pore size of typically 15 microns. Multiple passages 22 extend longitudinally through the body 21, and are lined with a thin layer 23 of fine-pore alumina. The pore size is chosen for the duty concerned, and for microfiltration is between 0.1 and 10 microns. For filtration of beer, a maximum pore size of 5 microns is typical. The feed beer is passed along the passages 22 and the clear permeate passes through the membrane-forming layers 23 and out through the coarsely porous body 21 as indicated by the arrows 24. The retentate continues along the passages 22.

The figures 3 and 4 show a filter unit having one module 25 mounted in a stainless steel outer casing 26 although, in most commercial applications, a plurality of modules will normally be mounted in a single casing. The ends of the modules are coated with a sealing coating to prevent by-passing, and are mounted in end assemblies 27, to which headers (not shown) are to be attached. The feed and retentate are fed into and collected from the passages 22 via the headers, and the permeate which passes out through the body 21 of the module 25 is drawn off through unions 28. Two such unions 28 are provided to enable circulation of sterilizing steam and cleaning solutions to clean the filter unit by backwashing.

Various other modifications may be made within the scope of the invention, as defined in the appended claims. In particular, the invention may be employed as a simple filtration system to clarify beer of initially low total solids content, normally using centrifugal pumping, or it may be employed, with positive pumping, to filter tank bottoms.

CLAIMS

1. A method of filtering beer (as hereinbefore defined) by a cross-flow filtration process, in which the filtering medium is formed by one or more ceramic membranes.

2. A method as claimed in claim 1, in which beer is fed to a primary filtration stage in which it is circulated past ceramic membranes so that the permeate constitutes the bulk of the usable beer, and the retentate is passed on to the secondary

6. A method of filtering beer substantially as hereinbefore described with reference to the accompanying drawings.

7. Apparatus for filtering beer (as hereinbefore defined) by a cross-flow filtration process, in which the filtering medium is formed by one or more ceramic membranes.

8. Plant for the manufacture of beer, including apparatus for filtering beer (as hereinbefore defined) by a cross-flow filtration process, in which the filtering medium is formed by one or more ceramic membranes.

9. Apparatus or plant as claimed in claim 7 or 8, comprising a primary filtration stage in which the beer is circulated past ceramic membranes so that the permeate constitutes the bulk of the usable beer, and a secondary filtration stage, also using ceramic membranes, to recover more beer from the retentate.

10. Apparatus or plant as claimed in claim 9, comprising a co ling means to cool the beer during recirculation past the membrane in either or both filtration stages.

11. Apparatus or plant as claimed in any of claims 7 to 10, in which the ceramic membrane includes a support body in the form of an elongate module having a plurality of parallel longitudinal channels each lined with a membrane layer of fine-pore ceramic.

12. Apparatus or plant as claimed in any of claims 7 to 11, in which the ceramic membranes has a pore size to constitute a micro-filter.

13. Apparatus for the filtration of beer substantially as hereinbefore described with reference to the accompanying drawings.

14. Beer when filtered by a method as claimed in any of claims 1 to 6 or in an apparatus or plant as claimed in any of claims 7 to 13.

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